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Sedimentation Rates in Paired Streams During High Precipitation Events on Elk Creek

Joseph Radel

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Joey Radel and Dr. Dan Ressler

Department of Earth and Environment Sciences, Susquehanna University, Selinsgrove, PA, 17870

Introduction:

One of the biggest issues in water quality is sediment erosion and transportation. Sediment erosion is a main cause to farm fields and pasture losing soils and the quality of the soil. Tons of sediment is put into waterways every day. Stream beds retain fine sediment in low flow events, but in high flow events fine sediment discharge of clay and slit happen. The research focuses on sedimentation during high precipitation events on two different tributaries of Elk Creek located on the King property, outside of Rebersburg, Pennsylvania. The agricultural stream on the King Property, and the forest stream across from the King property just upstream, both flow into Elk Creek. Elk Creek is a small tributary to the Susquehanna River which is the largest freshwater to the Chesapeake Bay. During the stream research, a study will be done on highlighting the difference in sediment loss and transport in a function of different land use. The streams are similar in discharge and drainage. One stream is an agricultural stream with pastureland containing animals and crops, and the other stream is a forest stream with lots of tree coverage and evergreens, with a rocky streambed. Elk Creek has undergone stream restoration and rehabilitation through the efforts and help of the Chesapeake Conservancy. Efforts for the future will be to implement barnyard restoration using best management practices such as a riparian buffer and cattle enclosure on the agricultural stream. This research will provide data for pre-restoration to help understand the effectiveness of the implemented best management practices.

Methods:

Four auto sampling devices were deployed in four different locations to collect 500 milliliter water samples every six hours for 30 days. Two streams, one agricultural and one forest where two auto samplers were placed upstream and downstream at each stream approximately 150 meters from each other. Once every six days, samples were collected, and water samples were analyzed. Field tests done such as pH, dissolved oxygen, conductivity, and turbidity were recorded by using a WTW Multi 350i multimeter. Water samples that were showing unusual data such as high or low turbidity were brought back to the lab to be analyzed. A chemical analysis for carbon and total nitrogen was conducted using a TOC-L chemical analyzer for total carbon nitrogen ratios. Sediment size analysis was conducted by a hydrometer testing.

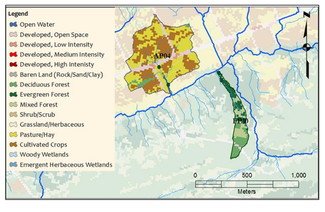

Figure 1: Two Elk Creek sub-watersheds, the Barnyard site is mostly cultivated or pasture lands, while the reference site is mostly deciduous, mixed, or evergreen forest.

Figure 2: A photograph of the equipment used in the field for water sample testing.

Figure 3: A photograph of the Barnyard and the stream in the Barnyard.

Data:

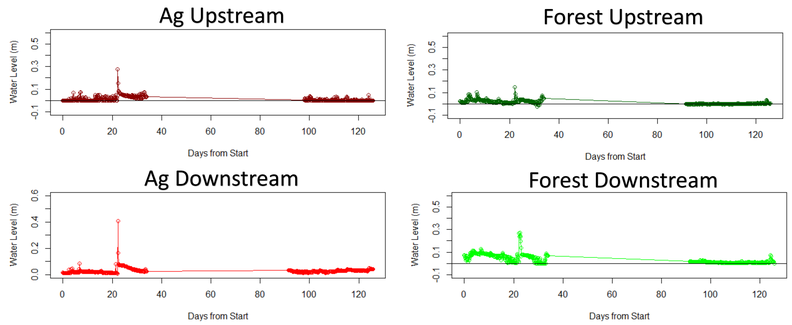

Figure 4: Water levels show all sites received a significant flow even around day 23, while the rest of the monitoring period was relatively quiet.

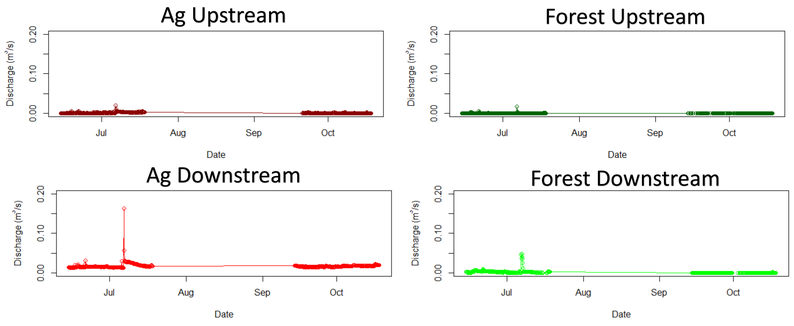

Figure 5: Discharge was calculated from water level measurements and ratings curves every three hours. Only the July 8th storm produced a significant spike in discharge, in fact, most other streams were mostly dry.

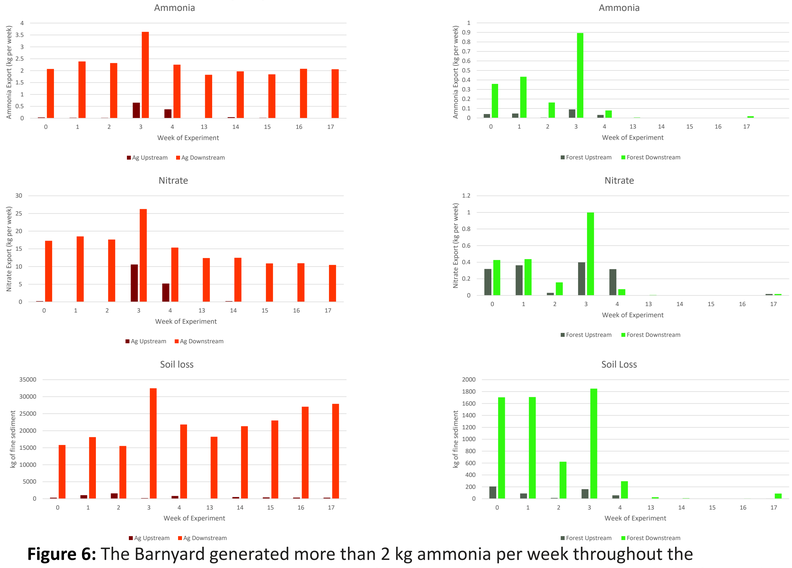

Figure 6: The Barnyard generated more than 2 kg ammonia per week throughout the experiment, more than 10 time larger than the inflow to the barnyard or through the forested reference. The Nitrate export was about 10 time larger than the forest export and the barnyard input, and the soil lost was nearly 20 times larger than either the barnyard input or the forest reference

Discussion:

Between the two watersheds, the land use is drastically different. One is forest base with rocky streambed, and the other one is agricultural base with vegetation, crops, and animals that are free to enter the stream. Both these watersheds send sediment and nutrients into Elk Creek which flows into the Susquehanna River and finally to the Chesapeake Bay. With the difference in land use, different levels in water quality and water chemistry appear.

Chemical analysis of the two watersheds present an extreme difference from water level to discharge. During the summer months both Ag stream and Forest streams had higher water levels compared to the fall months due to more rain fall occurring during the summer. The fall months had very little or no rain at all creating water levels to be almost zero, if not zero. In the Ag downstream water levels were normal due to springs in the barnyard field flowing at the downstream location.

Ammonia, nitrate, and soil loss were conducted. After ammonia calculations, the Ag downstream had a between 10 to 20 times more nutrients and sediments lost by the barnyard compared to the forest reference compared to downstream. An increase of ammonia occurred during rain fall, which also increased the upstream ammonia amount, but once no more rain fall the ammonia levels were back to zero. Nitrate calculations were very high in Ag downstream and only occurred in upstream during rain fall. Forest downstream had a small amount of nitrate during the summer months and increased during rain fall, compared to the fall months with little to no rain fall. Main goal in the research was soil loss. After calculations, the Ag downstream numbers were huge. Creating an average of 283 tons of soil loss into the water going into Elk Creek and ending in the Chesapeake Bay.

Conclusions:

The two watersheds were drastically different. After test and calculations were done, the results came back with numbers that show this would be a great opportunity for a restoration. A restoration would help decrease the amount of sediment lose into Elk Creek. With decreasing the loss of sediment and loser the amounts of ammonia and nitrate in the water it would increase the water chemistry. Not only would the water chemistry improve, but also the soil lost would decrease keeping the soil in the ground improving the land and soil. .

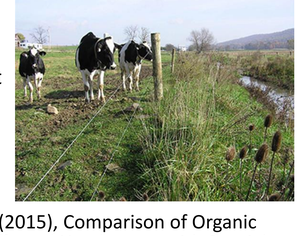

Figure 7: A photograph of what a restoration might look like.

References:

Heinz, M., D. Graeber, D. Zak, E. Zwirnmann, et al., (2015), Comparison of Organic Matter Composition in Agricultural versus Forest Affected Headwaters with Special Emphasis on Organic Nitrogen, Environmental Science and Technology, 49(4), 2081-2090.

Weller, D. E., Baker, M. E., Jordan, T. E., (2011), Effect of riparian buffers on nitrate concentration in watershed discharges: new models and management implications, Ecological Applications, 21, (5), 1679-1695